Space Weather Technical Forecast

Issued on Tuesday, 15 November 2022 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (Minor to Moderate radio blackouts) throughout. Slight chance of S1 (Minor) Radiation Storms and X-class flares (Strong radio blackouts).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours has been Moderate, with numerous mid-upper C-class flares and one M-Class flare from the largest region on the disc in the northwest (AR3140). AR3140 has shown continued strengthening of its intermediate spots, with increased magnetic complexity to delta configuration at times. The region is now classified Ekc/Beta-gamma and poses the most significant risk for further flares at this time. AR3141 (Cao/Beta) to the south of AR3140 has continued to slowly decay and appears simpler and smaller than at the start of the period. AR3145, again in the northwest, shows minor growth, with a fairly large longitudinal extent and minor spot proliferation, with it subsequently being reclassified as a Bxi/Beta. The remaining spot, AR3146 in the northeast, remains relatively simple and stable.

No significant Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 by DSCOVR, was indicative of waning high speed stream influences. Wind speeds were slightly elevated, varying, but on a declining trend between 410-440km/s. Density has been at average to below average levels. Total magnetic field strength (IMF) has been weak throughout, between 4-6 nT. The north-south component, Bz, has fluctuated weakly between +5/-4 nT. Phi angle has been largely negative (towards the Sun), but with some short-lived fluctuations into a positive (away from sun) sector. Geomagnetic activity was Quiet (Kp 0-2) throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background levels. High energy electron flux (greater than 2 MeV) at GOES-16 has been at background to moderate levels, with a peak of 217 pfu at 14/2205 UTC. Electron fluence levels remained well below Active (1e8 integrated pfu) levels, with a very slight rising trend. Observed fluence at 15/0001 UTC was 4.93e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with a chance of isolated M-class flares during the period. There is a slight chance of isolated X-Class flares, most likely from AR3140.

Solar Wind / Geomagnetic Activity: No significant Earth-directed CMEs are expected during the period, though some minor CME effects are possible from a glancing blow on 18 Nov.
Solar winds are currently at slightly elevated levels due to the waning influences of weak coronal holes. Winds are expected to continue to slowly decline through Day 1 (15 Nov). Further enhancement is possible from weak coronal hole influence into Day 2 (16 Nov) from two small

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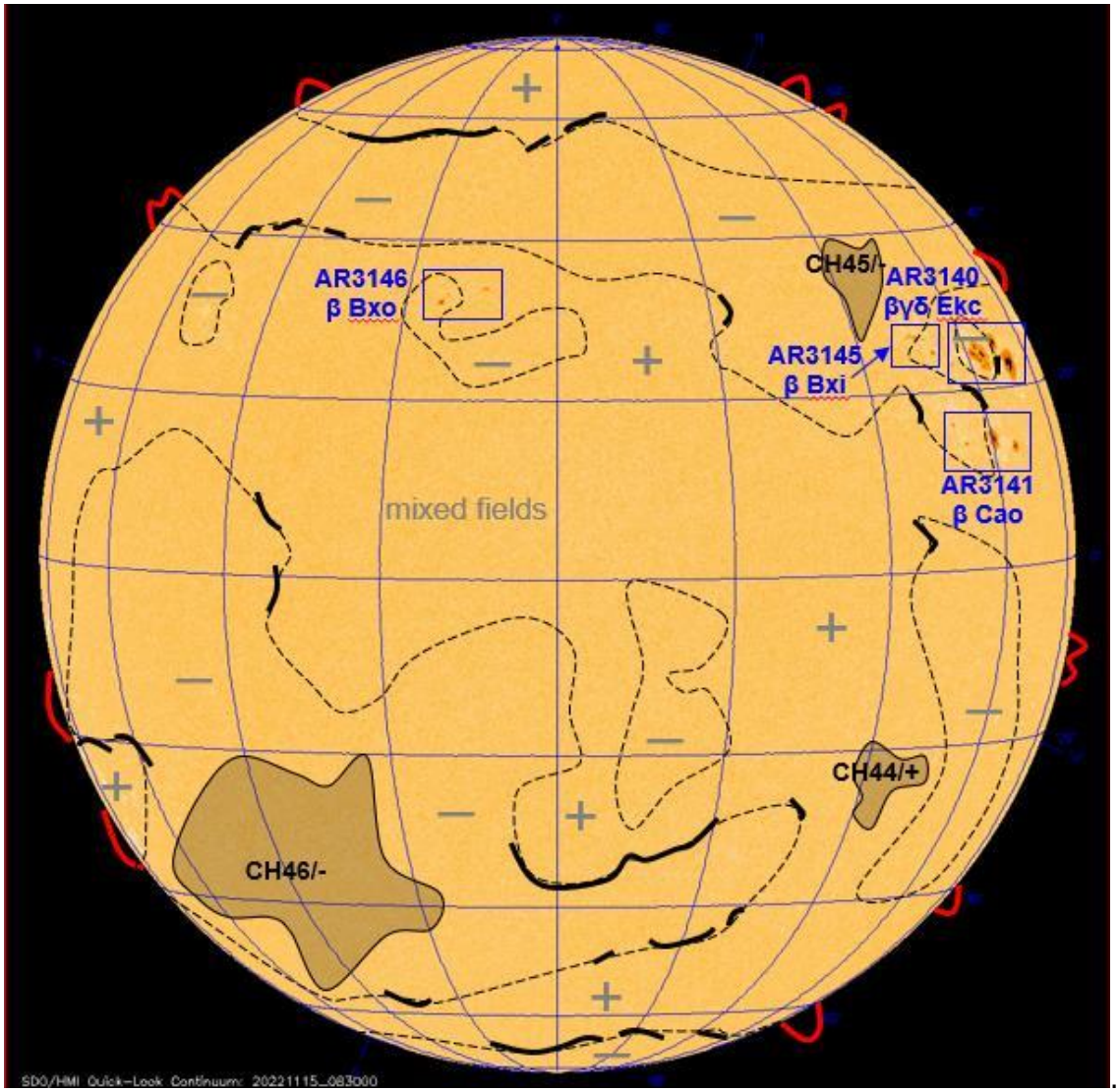
coronal holes. Geomagnetic activity is expected to be predominantly Quiet to Unsettled through the period. There is a chance of isolated Active intervals if we encounter any CIRs associated with the two coronal holes late on Day 1 or Day 2, or if we experience weak CME related enhancements during Day 4 (18 Nov).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) observed by GOES-16 is most likely to remain at background levels throughout. However, there is a slight chance of an increase in solar radiation from AR3140 and AR3141 in the far western solar hemisphere. Electron flux is forecast to remain at mostly background to moderate levels throughout the period. Moderate or perhaps briefly High electron flux is possible at diurnal maxima from Day 3 (17 Nov) onward. Fluence values are expected to remain below or well below the Active (1e8 integrated pfu) threshold throughout the period.

Figure 1. Solar Analysis Valid 15/0830 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No significant Earth-directed CMEs are expected during the period, though some minor CME effects are possible. Two filament lift-offs were observed on the 13 Nov and 14 Nov, these are expected to pass ahead of Earth's orbit, but could give a glancing blow on 18 Nov. Significant impacts are unlikely if encountered at Earth.

Solar winds are currently at slightly elevated levels due to waning coronal hole influences. Winds are expected to continue to slowly decline through Day 1 (15 Nov) to slow-ambient. Further enhancement is possible from weak coronal hole influence into Day 2 (16 Nov) from two small coronal holes at a similar longitude on the visible disc: CH45/- in the north and CH44/+ in the south. Although it is difficult to tell which of these features may become geoeffective at Earth as they are similar latitudinal distances away from Earth's position relative to the ecliptic.
STEREO-A data suggests a weak CIR was encountered over the last 12-18hours, suggesting something similar arriving here overnight into Day 2 (16 Nov).

Geomagnetic activity is expected to be mainly Quiet in the next 24hrs, with an increasing chance of Unsettled intervals. There is a chance of isolated Active intervals later on Day 1 or Day 2 (16 Nov) if CIRs are encountered associated with the two small coronal holes. A further chance of Active intervals on Day 4 (18 Nov) is possible if we see any weak CME related enhancements.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil expected.

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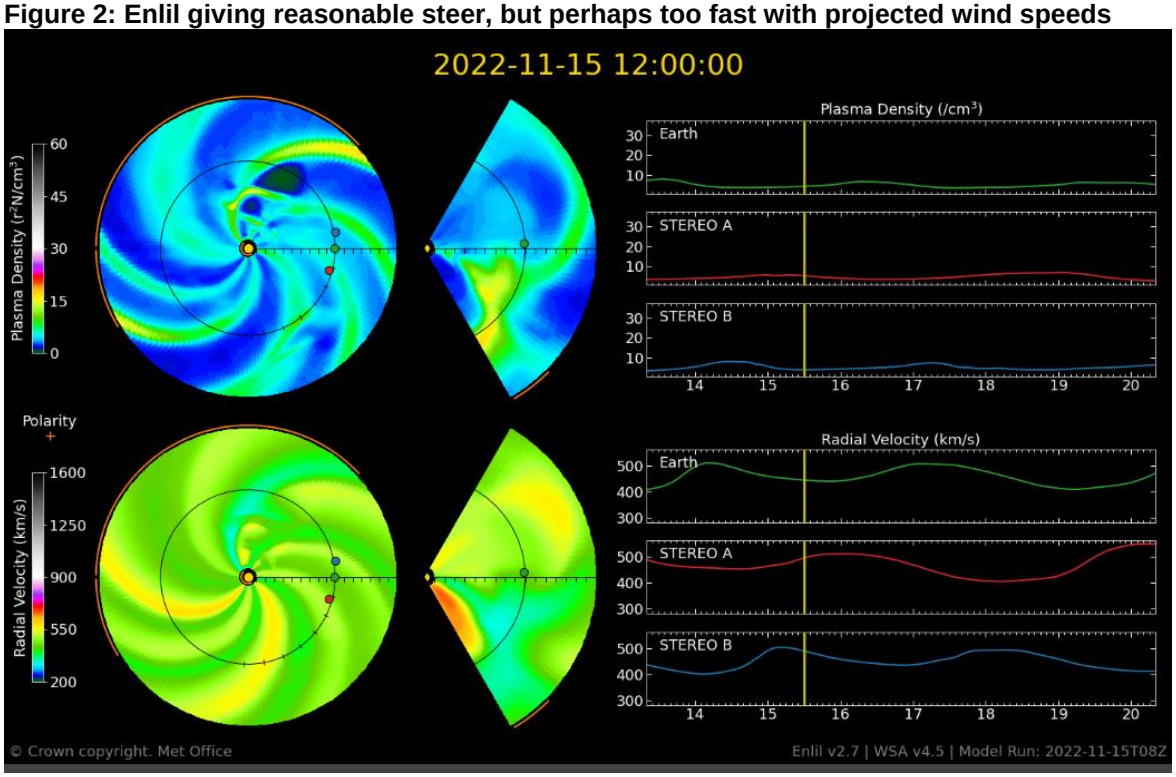
Figure 2: Enlil giving reasonable steer, but perhaps too fast with projected wind speeds



Radio Blackouts - X-Ray Flares:

Solar activity is expected to remain at Low to Moderate levels throughout the period. There is a chance of isolated M-class flares during the period and a slight chance of isolated X-flares, most likely from AR3140.

There are currently four numbered solar regions on the visible disc. AR3140 (Ekc/Beta-gamma) in the far northwest remains the largest, most active and most complex region, with frequent C-class activity. The magnetic complexity of the trailing spot has decreased, with a delta spot no longer discernible, as such the group has been reclassified a Beta-gamma. AR3141 in the northwest remains of a similar size and complexity, with some of its trailing spots continuing to fade. AR3145, again in the northwest, shows minor growth, with a fairly large longitudinal extent and minor spot proliferation, with it subsequently being reclassified as a Bxi/Beta. AR3146 in the northeast has shown minor decline, and remains a relatively simple and stable region.

AR3140 and AR3141 are expected to fully rotate off the visible disc on Day 3 (17 Nov) and Day 4 (18 Nov) respectively, although they will still pose some risk of flaring until well beyond the western limb. Two new bright regions of flux (evident on STEREO-A EUVI 304 imagery) are, or will be rotating over the eastern limb in the southern hemisphere in the next 24-36 hours, although it is difficult to fully assess the likelihood of flaring from these until they appear on available imagery, which is reflected in the flare probabilities through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)

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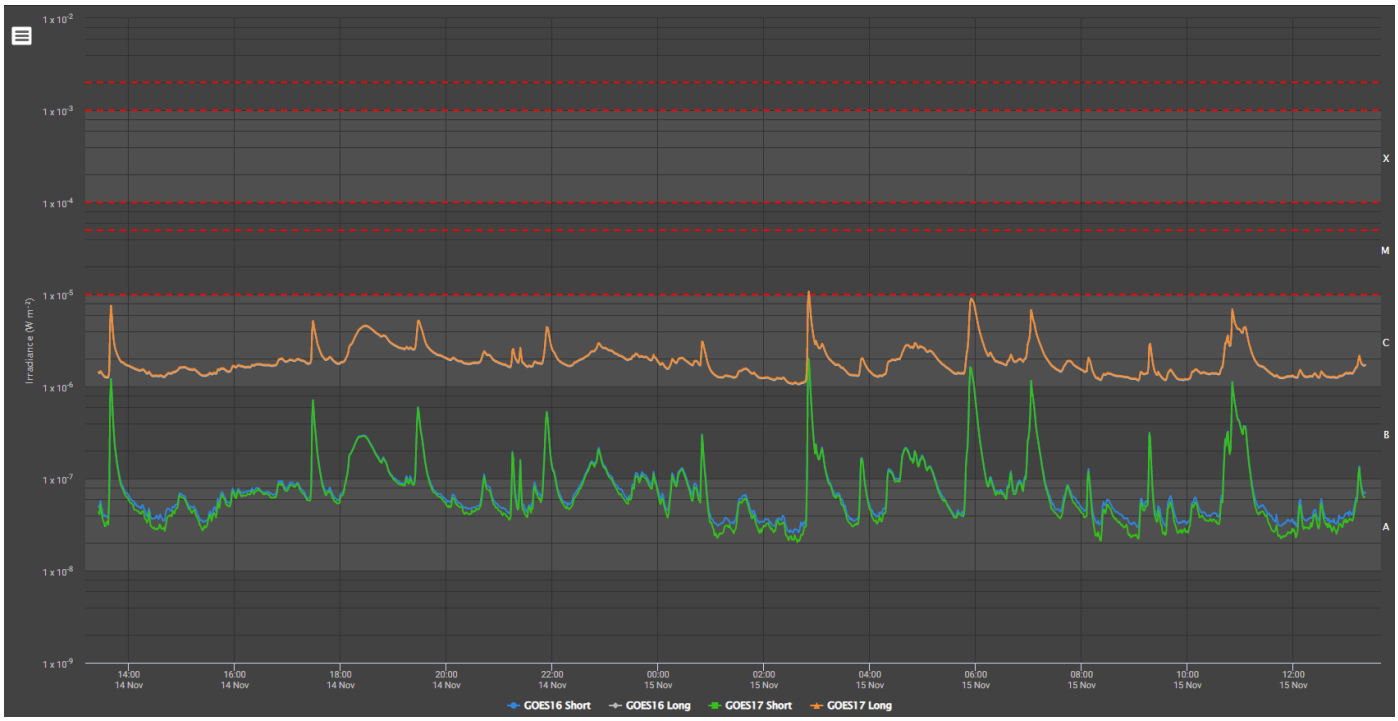
Active	**R1-R2 M Class**	No	50	50	50	50
Very Active	**R3 to R5 X Class**	No	15	15	15	15

Figure 3: X-Ray trace over past 24 hours at GOES-16



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) at GEO, as observed by GOES-16, is currently at background levels and is most likely to remain at this level throughout the period. However, as AR3140 and AR3141 continue to transit across the western solar hemisphere they give a slightly increased risk of proton storms over background conditions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):
Electron flux (greater than 2MeV) is currently at mostly background levels and is forecast to be at background to moderate levels through much of the period. The arrival of weak HSS influence from two coronal holes is probable either late Day 1 (15 Nov) or early Day 2 (16 Nov), although significant charging is considered unlikely from these features. Moderate or perhaps briefly High electron flux is possible at the diurnal maxima from Day 3 (17 Nov) onwards, but persistently high levels are considered unlikely, with reasonable confidence.

Electron fluence values are well below the Active (1e8 integrated pfu) threshold and are expected to remain so throughout the period, with a slight rising trend possible from Day 3 (17 Nov). The MOSWOC REFM currently supports electron fluence values remaining below the Active threshold, despite this slight rising trend. Fluence levels on the last rotation remained below the Active threshold with slightly faster wind speeds, a similar trend seems reasonable.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	1	5	5
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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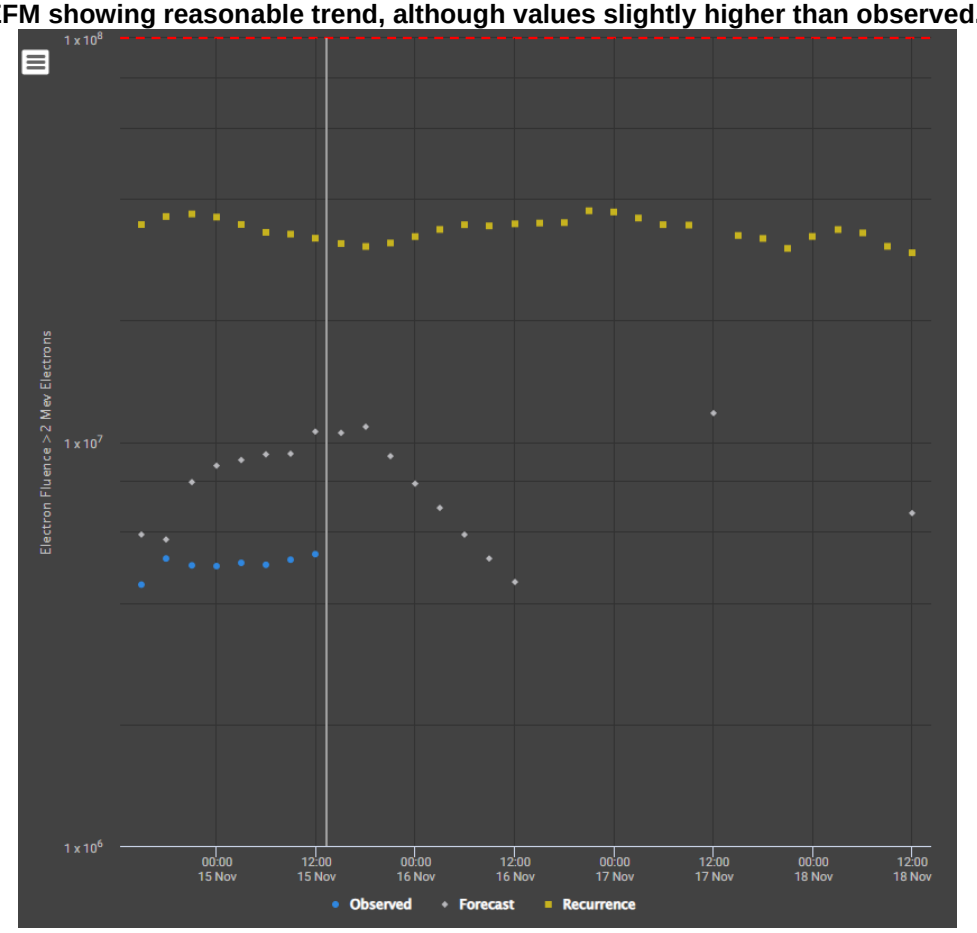
Figure 5: REFM showing reasonable trend, although values slightly higher than observed.



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